

State Agency Needs For Monitoring and Assessment in Support of 305[b] and 303[d]

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National Academy of Sciences Committee to Assess Science in TMDLs¹

Two Major WQ Program Areas Identified as Needing Improvement:

- **Water Quality Standards**
- **Monitoring and Assessment**

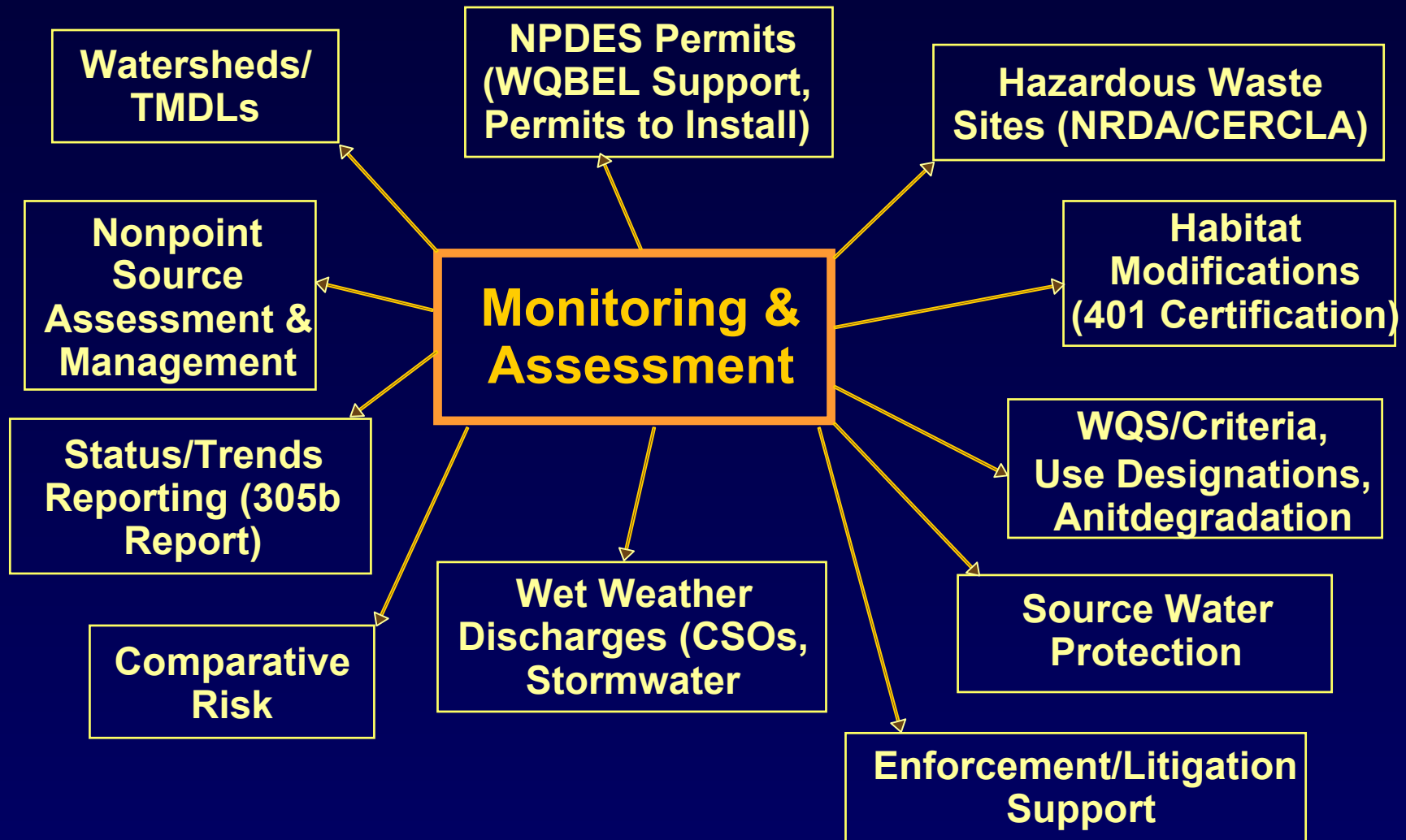
¹NRC (2001). Assessing the TMDL Approach to Water Quality Management

Monitoring & Assessment Should Be a Determinant in How WQ is Managed

- Problem identification and characterization.
- Policy/program and legislation development.
- Criteria development and application.
- Demonstrate WQ management program effectiveness, *i.e.*, manage for environmental results.

Develop monitoring & assessment as an overall function of WQ management, not on a piecemeal basis.

Better Monitoring & Assessment Supports All Water Quality Management Programs



Fundamental Objectives of Adequate Monitoring and Assessment Approaches

Function: Surface Water Assessment

- Collect and analyze baseline information.
- Establish cause/effect (causal associations).
- Compare results to criteria and goals (use attainment).
- Publish results - statewide, regional, site-specific.

Function: WQ Mgmt./Pollution Abatement

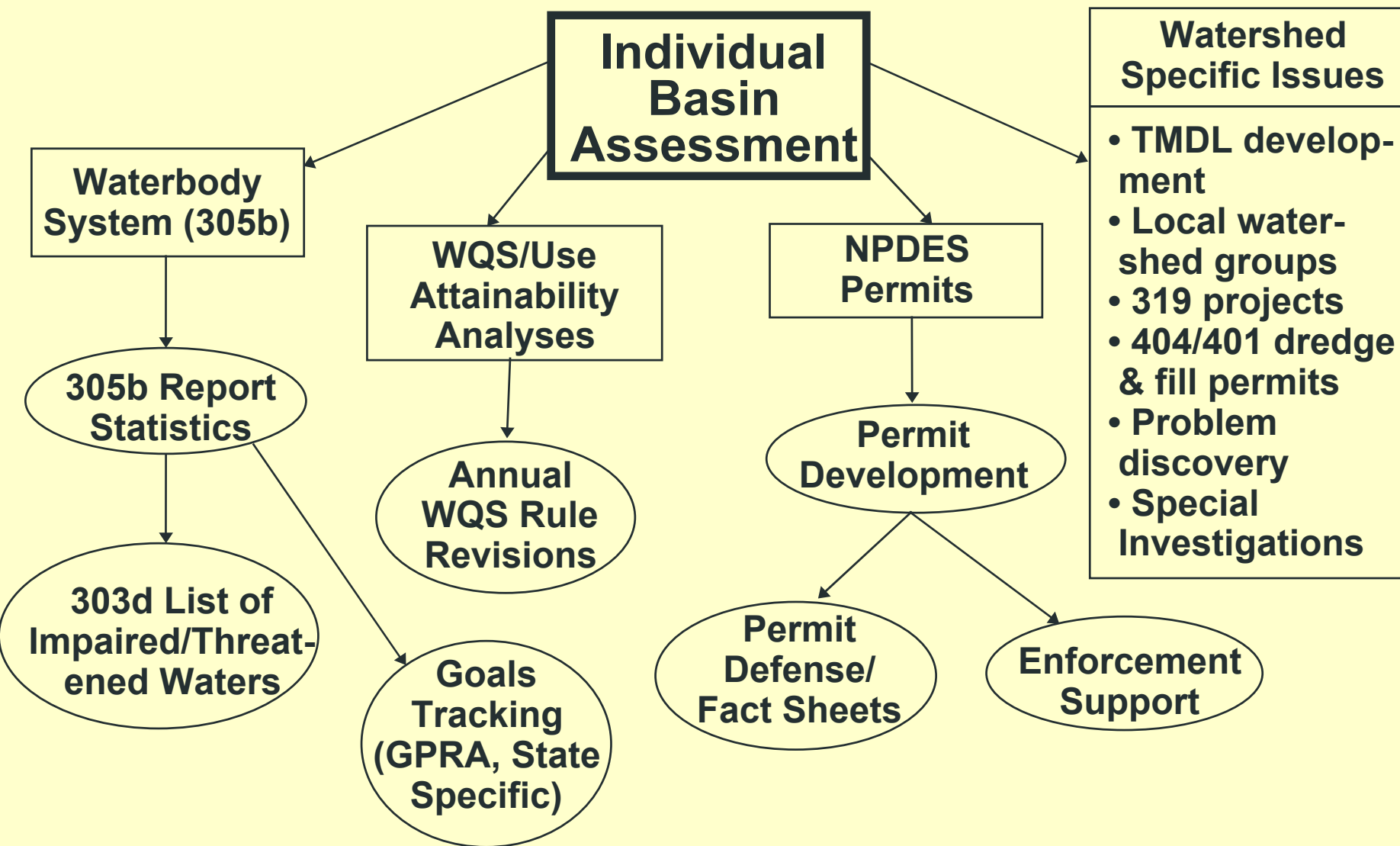
- Attainability analyses and criteria development (maintain WQS).
- Formulate and revise abatement strategies (TMDL development).
- Assess effectiveness of programs (WQ Management).

Function: Compliance Evaluation

- Monitor to determine compliance.
- Monitor to support enforcement.

after 40CFR Part 35 (deleted in 1990?)

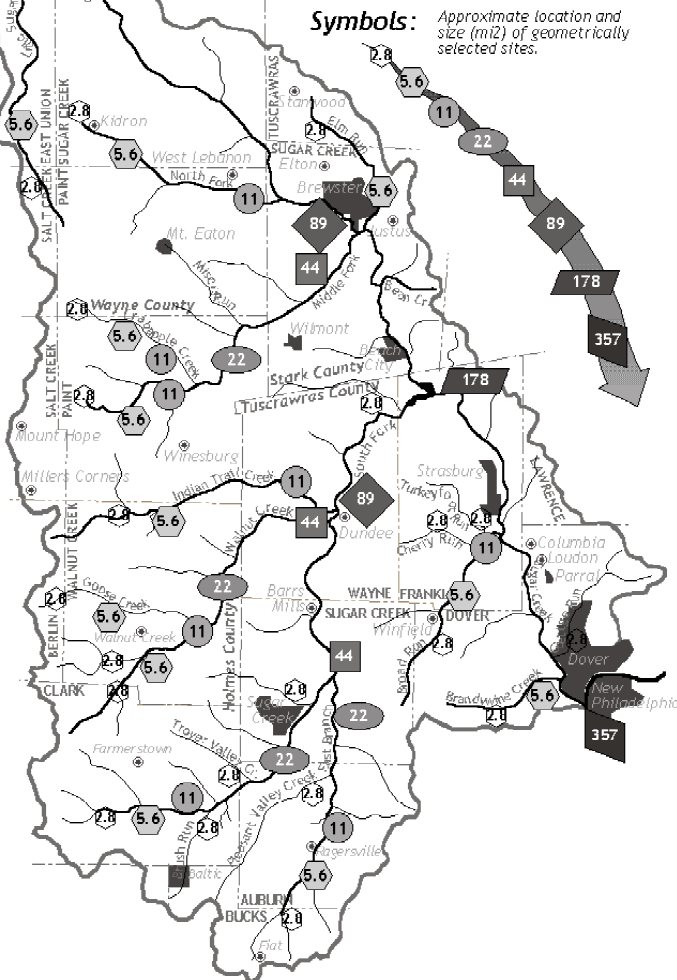
Functional Support Provided by Annual Rotating Basin Assessments



Sugar Creek

Geometric Site Selection

Sequential subdivision by halves of the entire 357 mi² basin yields subbasin areas of 178 mi², 89 mi², 44 mi², 22 mi², 11 mi², 5.6 mi² and 2.8 mi². Sites which most closely matched these stratifications were selected for inclusion in the Ohio EPA 1998 Sugar Creek watershed study.



Sugar Creek Subbasin: Example of Geometric Site Selection Process

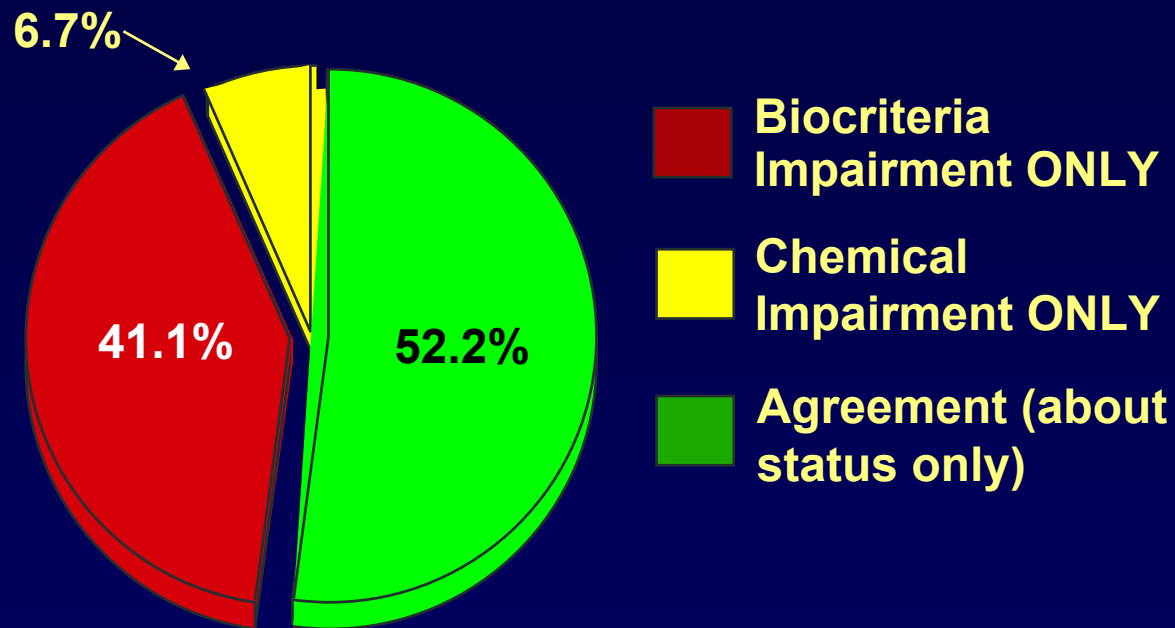
- Support 15 yr. TMDL development schedule beginning in 1998
- Augmented by 5-year basin approach database (1980-1997)
- Standardized biological, chemical, and physical tools and indicators
- Increased miles of assessed streams and rivers annually
- **Resolve undesignated streams**
- **Close 305b/303d listing gaps**
- **More comprehensive coverage of small streams (<5-10 mi²**
- **Generate broader database for development of improved tools**

Symptoms of An Incomplete Foundation in Water Quality Management

- General or “colloquial” uses and criteria
- Reliance on prescriptive approaches
- Reliance on anecdotal information
- Emphasis on administrative outcomes
- Point source focused and translation of concepts to NPS and TMDLs
- Inconsistent environmental statistics reported between States (305b, 304l, 303d, etc.)
- Lists that are too short
- Lists that are too long

Chemical vs. Biological Indicators of Aquatic Life Impairment:

Relative performance of chemical water quality criteria compared with biological criteria in detecting aquatic life impairments:



2543 Sampling Sites
(1994 Ohio 305b Report)

Major Classes and Types of Environmental Indicators: Problem Statement

1. **Stressor Indicators** (e.g., loadings, land use, habitat)
2. **Exposure Indicators** (e.g., chemical-specific, biomarkers, toxicity)
3. **Response Indicators** (e.g., biological community condition)

The problem nationally has been with the inappropriate use of stressor and exposure indicators as response indicators.

CORE INDICATORS

- Fish Assemblage • Macroinvertebrates • Periphyton
- (Use Community Level Data From At Least Two)*

Physical Habitat Indicators

- Channel morphology • Flow
- Substrate Quality • Riparian

Chemical Quality Indicators

- pH • Temperature
- Conductivity • Dissolved O₂

For Specific Designated Uses Add the Following:

AQUATIC LIFE

Base List:

- Ionic strength
- Nutrients, sediment

Supplemental List:

- Metals (water/sediment)
- Organics (water/sediment)

RECREATIONAL

Base List:

- Fecal bacteria
- Ionic strength

Supplemental List:

- Other pathogens
- Organics (water/sediment)

WATER SUPPLY

Base List:

- Fecal bacteria
- Ionic strength
- Nutrients, sediment

Supplemental List:

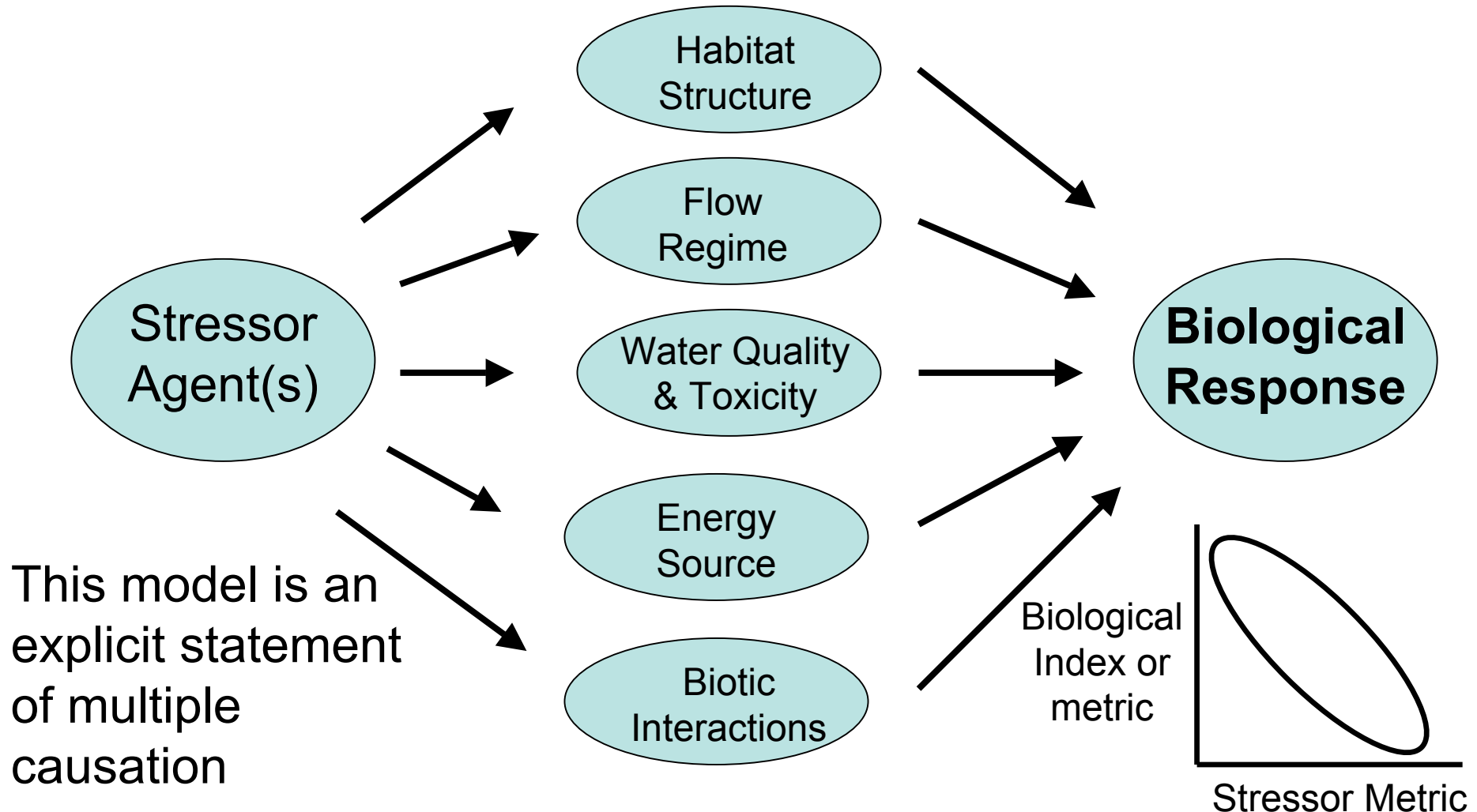
- Metals (water/sediment)
- Organics (water/sediment)
- Other pathogens

HUMAN/WILDLIFE CONSUMPTION

Base List:

- Metals (in tissues)
- Organics (in tissues)

The Linkage From Stressor Effects to Ecosystem Response



Water Quality Standards: The Basis for Water Quality Management

- Basis for implementing controls & management under CWA.
- Consist of uses and criteria.
- Focus of watershed planning and implementation.
- Benchmarks of evaluating effectiveness of controls, funding, permits, BMPs, TMDLs, etc.

States are the principal custodians of WQS and the associated designated uses and criteria.

EVOLUTION OF ASSESSING SURFACE WATER INTEGRITY: ADDING NEW & BETTER TOOLS

WATER QUALITY —————> WATER RESOURCE

- | | | | |
|----------------------------|----------------------------|--|---|
| • Simple Chemical Criteria | • More Chemical Criteria | • Complex Chemical Criteria | • More Complex Chemical Criteria |
| • One Aquatic Life Use | • Tiered Aquatic Life Uses | • Tiered Aquatic Life Uses | • Tiered Aquatic Life Uses |
| (1974 - 1978) | (1978 - 1980) | • Narrative Biological Criteria
(1980 - 1987) | • Numerical Biological Criteria |
| | | | • Whole Effluent Toxicity Tests |
| | | | • Physical Habitat Evaluation
(1987 - Present) |

LESS ACCURACY —————> MORE ACCURACY

Use Attainability Analysis II: Process and Information Requirements**

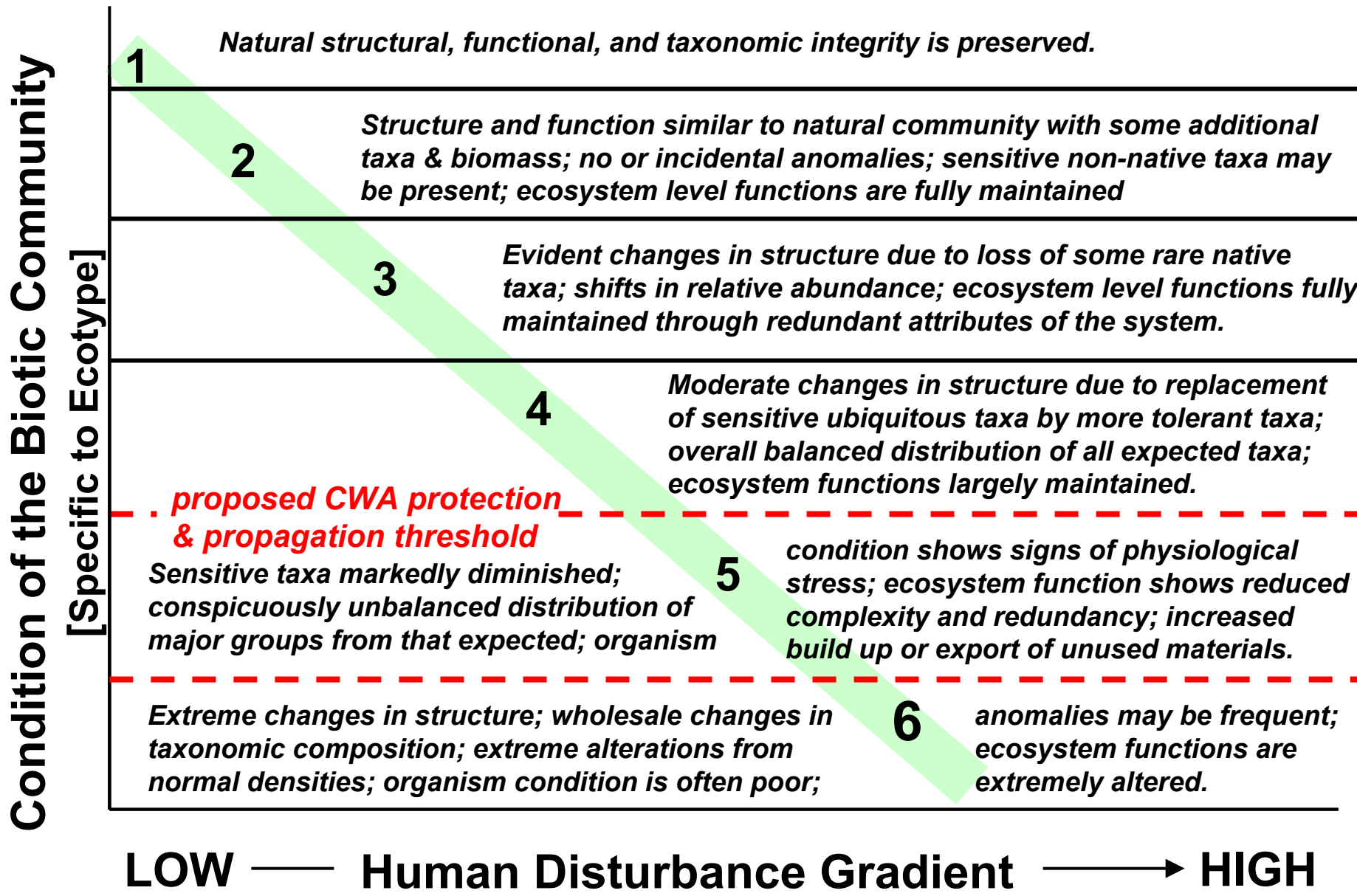
Use attainability analysis requires the following information and knowledge:

- existing status of waterbody based on biocriteria;
- habitat assessment to evaluate potential;
- reasonable relationship between impaired state and precluding activity based on assessment of multiple indicators used in appropriate roles;
- recommendation subject to WQS rulemaking process
- reviewable every three years - a "temporary" designation.

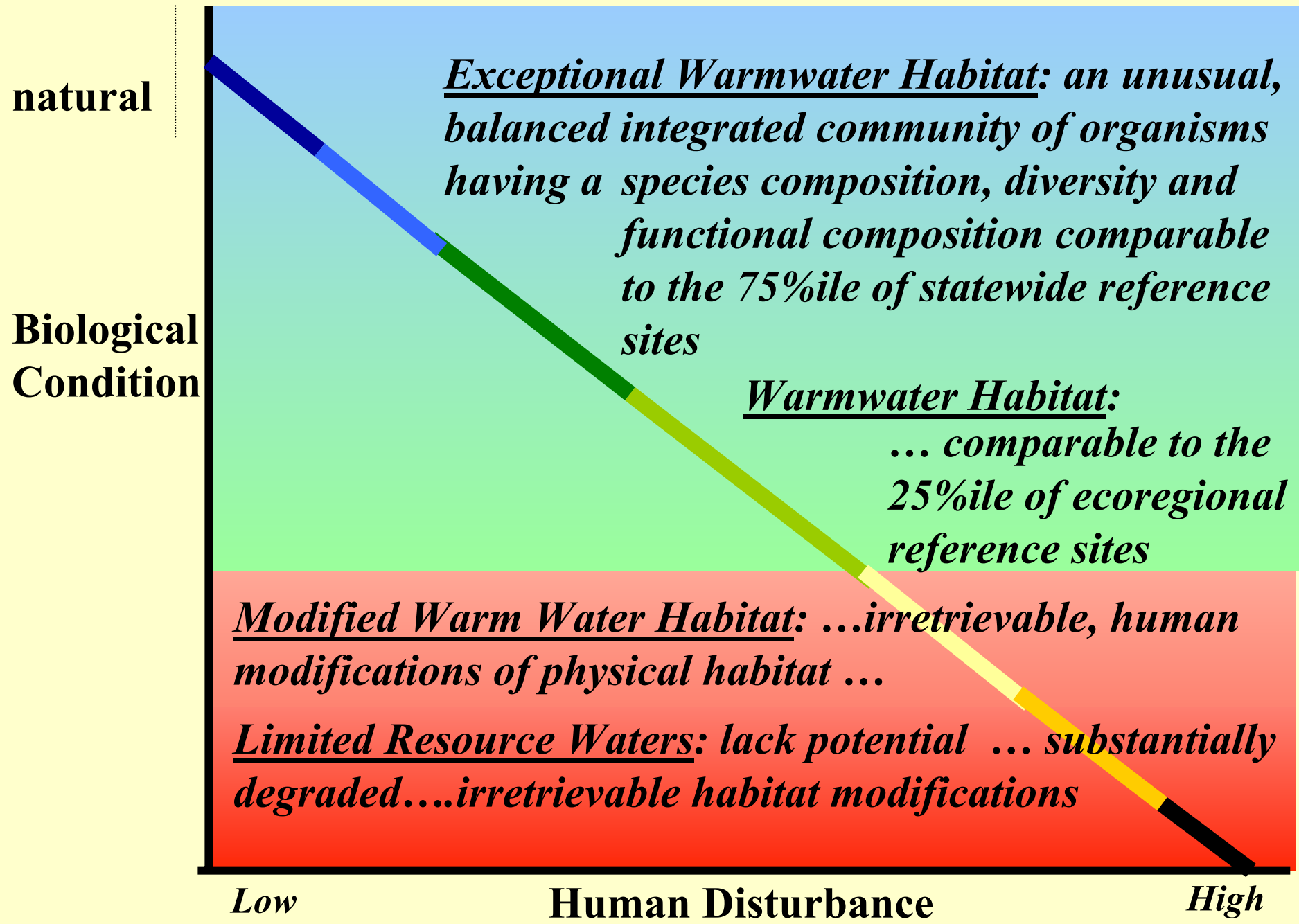
**** - All data collection and analysis must conform to Ohio WQS and Five-Year Monitoring Strategy data and design quality objectives.**

Tiered Aquatic Life Use Conceptual Model: Draft Biological Tiers

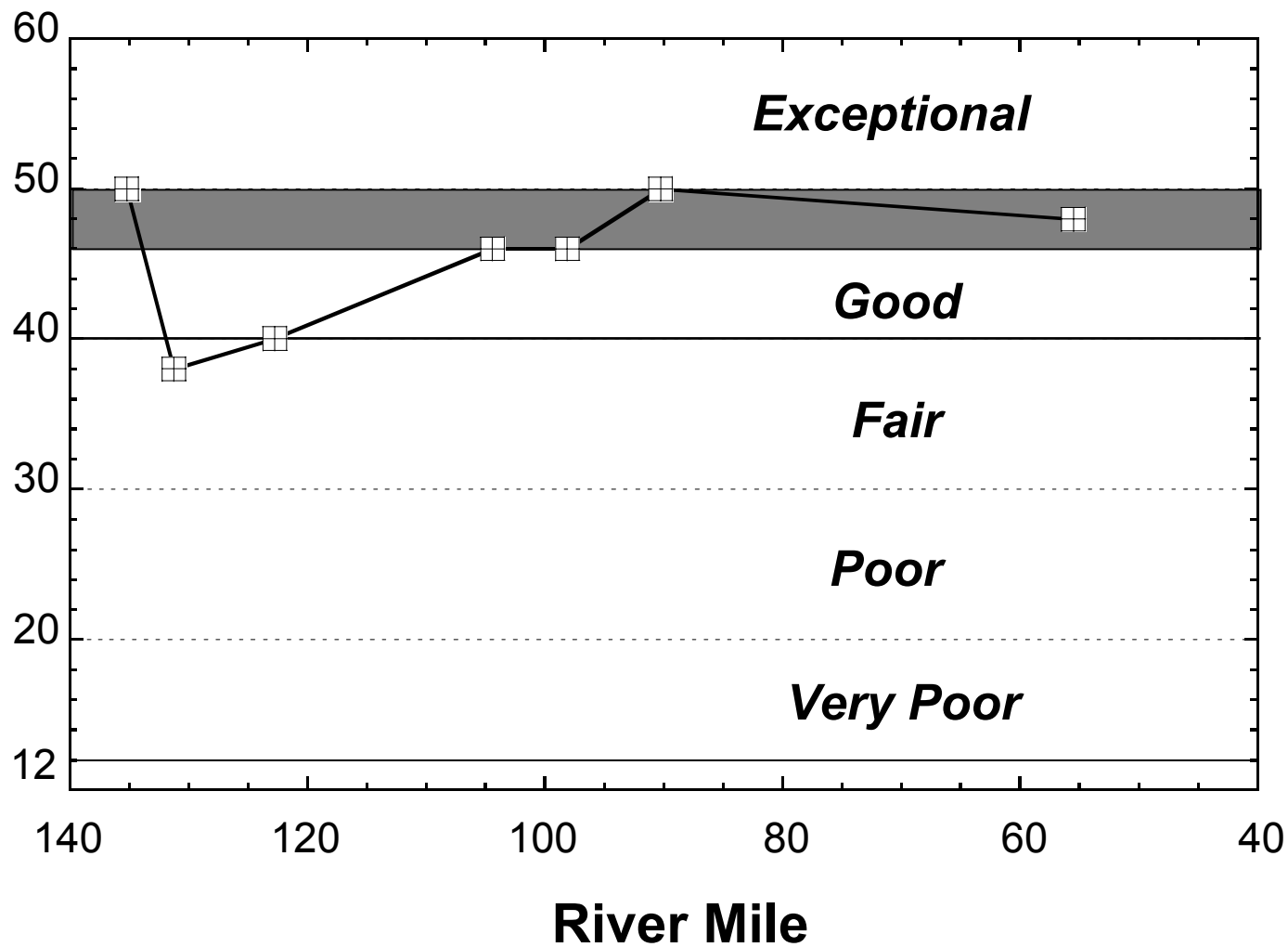
(10/22 draft)



Designated Aquatic Life Uses: Ohio/Streams & Rivers



INDEX OF BIOTIC INTEGRITY (IBI)



Reference condition and how biological condition are measured form the basis for determining what is acceptable vs. unacceptable, both of which require some management action.

- ***Designated Use*** – sets management goals and criteria for protection and restoration (Water Quality Standards).
- ***Management Action*** – protection or restoration activity or reconciling standards to attainable conditions (NPDES Permits, TMDLs, BMPs).

Resolution and Detail in WQS and Monitoring and Assessment Affect Overall WQ Management Program Effectiveness

<u>Program Attribute</u>	Least Accurate	→	Most Accurate
WQS/Des. Uses:	General Uses (Generic AQLU)		Refined Uses (Tiered AQLU)
WQ Criteria:	Simple, Chemical (Conventionals)		Chemical & Biological (Acute/Chronic, Biocriteria)
Monitoring:	Fixed Stations		Rotating Basins (Stratified, Probabilistic)
Indicators:	Chemical, Narrative		Chem., Phys., Biological (Numeric, Calibrated)
Detail:	Coarse (Low Signal)		Refined (Integrated Signal)
Resolution:	Pass/Fail (No Increments)		Incremental (Continuous Scale)

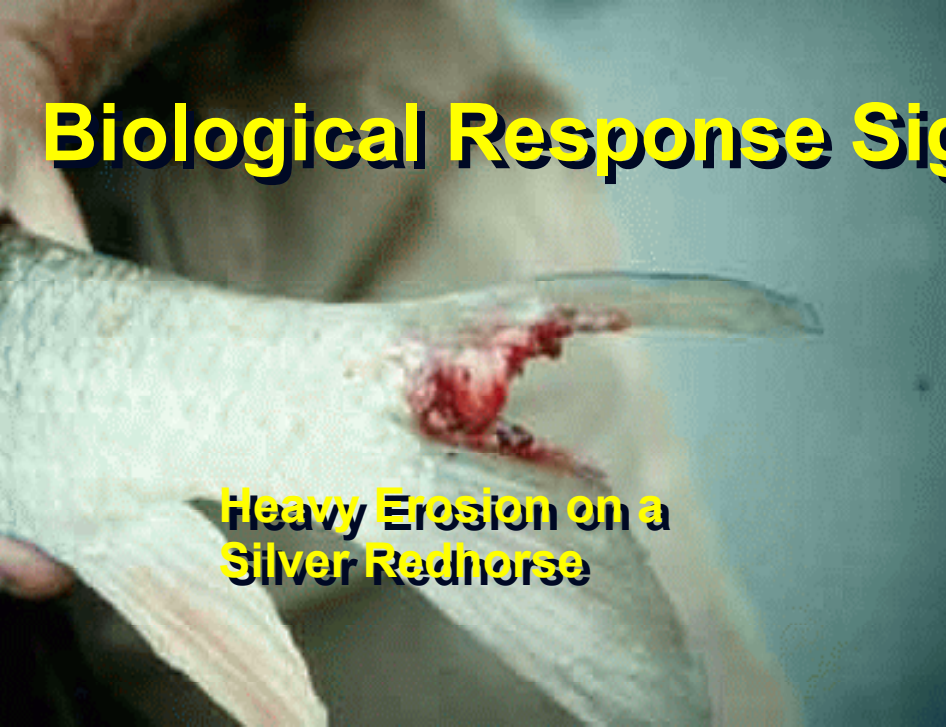
Completing the Cycle of Water Quality Management: Guiding the Results of Management Actions With Integrated Environmental Measures



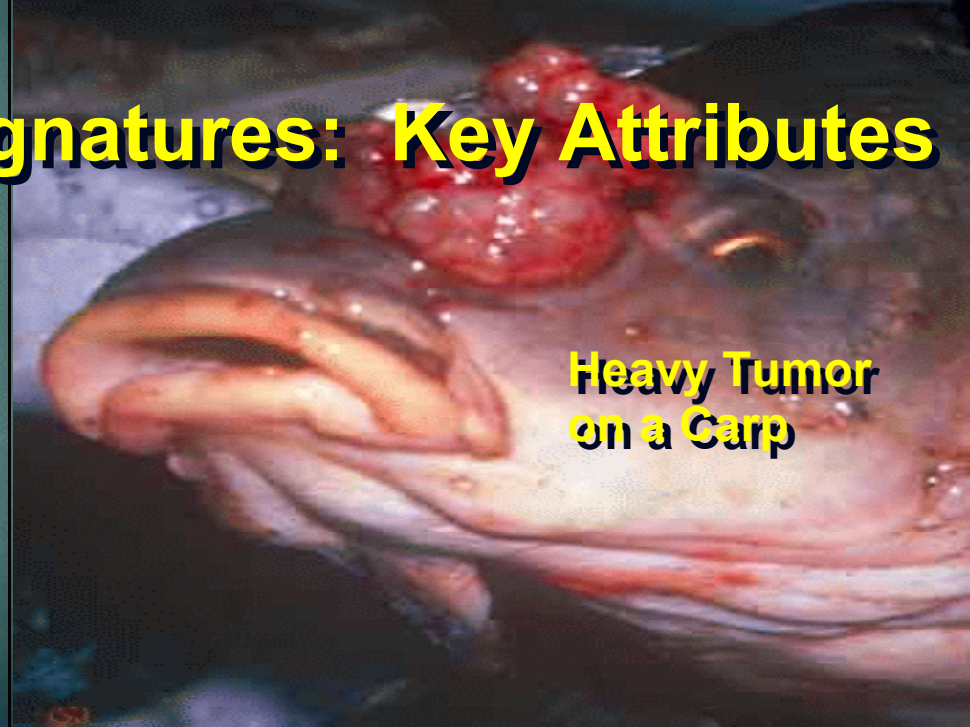
Multiple Indicators Matrix: Ottawa River

SEGMENT	DES. USE	RESPONSE INDICATORS				EXPOSURE INDICATORS						STRESSORS				
	Attainment Status	QHEI	IBI	MIwb	ICI	Water Chem	Sedi-ment Chem	Tox-icity	% DELT	Fish Tiss.	Bio-marker	# Dams/ Pools	Urban-Indust. Landuse	Cumulative Loads	Spills	CSO SSOs
Ottawa River mainstem - 1996																
Thayer Rd to Sugar St.	FULL-PART.	68	Fair-Good	Fair-Good	Good	Nitrates	Low	NA	Mbd-High	Mer-cury	Low	Mbd-e	Low	Low	Low	Low
Sugar St. to Lima WWTP	NON	47	Poor to Fair	Poor to Fair	Poor to M.G.	CBOD TSS D.O.	As,Cr Cd,Cu Ni,Zn	Mbd-erate	High	Pesti-cides	BUN Naph B(a)p	High	High	Mbd-erate	Mbd-e	High
Lima WWTP Allentown dam	NON	72	Poor	Poor to Fair	Fair to Good	Amm. CBOD TSS D.O. Nitrates Phos Chrom. PAH Pesticid	As,Cr Cd,Cu Ni,Zn PAH	Mbd-erate	Very High	Selen-ium Pesti-cides	EROD Naph B(a)p BUN	Mbd-e	High	High	High	High
Allentown dam to Kalida	PAR-TIAL	69	Poor -Fair	Fair-Good	Good -Exc.	TSS	Low	NA	High	Pesti-cides	Low	Low	Low	High	Low	Low
Kalida to mouth	FULL	69	Good	Good	Exc.	TSS	Low	NA	Very High	Pesti-cides	Low	Low	Low	High	Low	Low

Biological Response Signatures: Key Attributes



Heavy Erosion on a Silver Redhorse

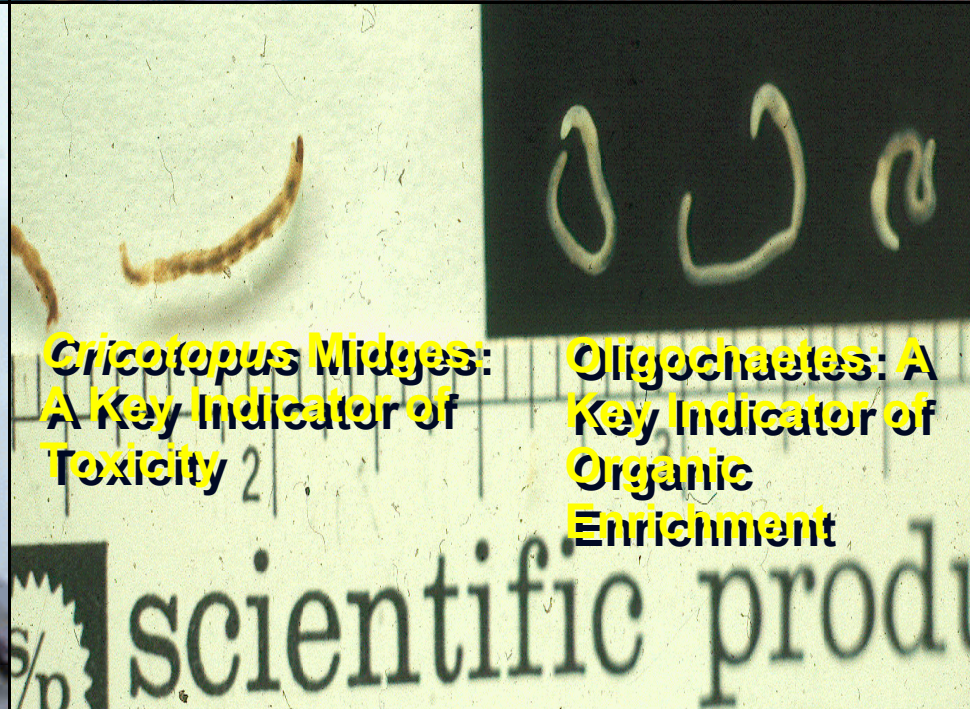


Heavy Tumor on a Carp



Heavily Eroded Barbels & Deformities on a Yellow Bullhead

Normal Barbels on a Yellow Bullhead



Cricotopus Midges: A Key Indicator of Toxicity

Oligochaetes: A Key Indicator of Organic Enrichment

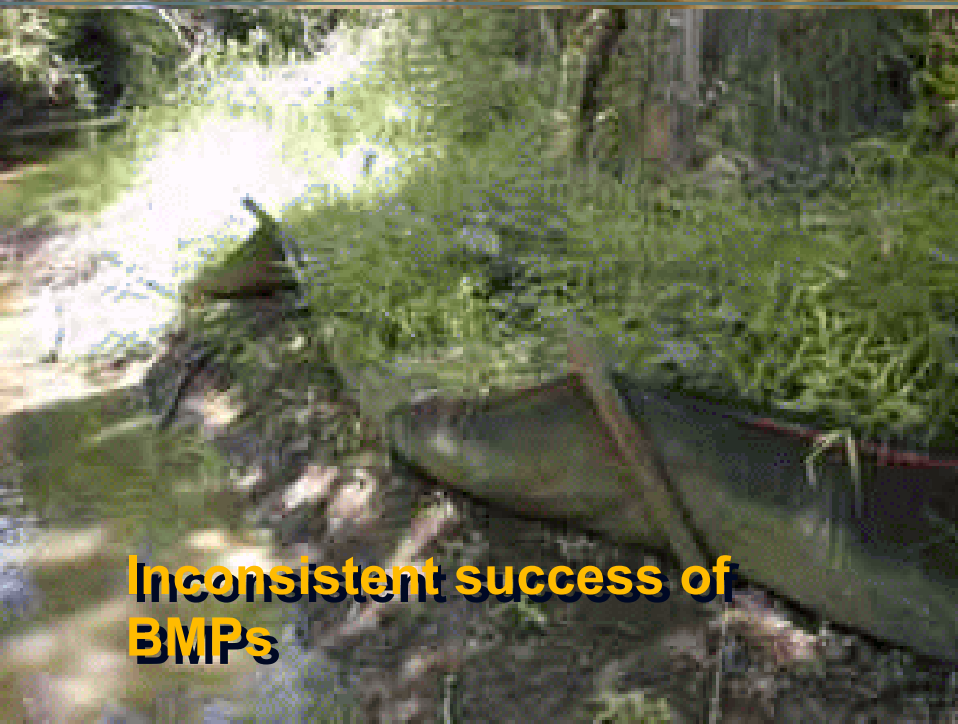
Rocky Fork: Impacts of Suburban Development in the 1990s



Rocky Fork Biological Assessment

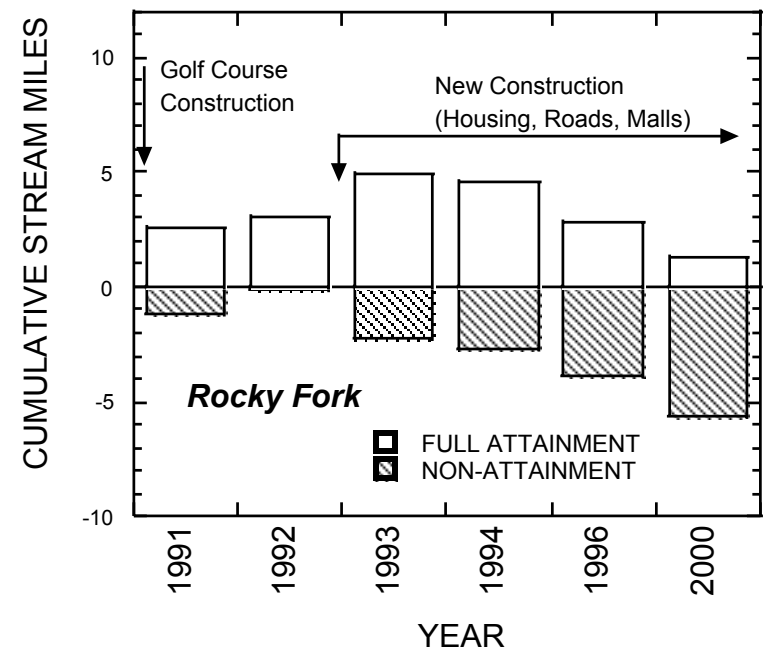


High Density Housing

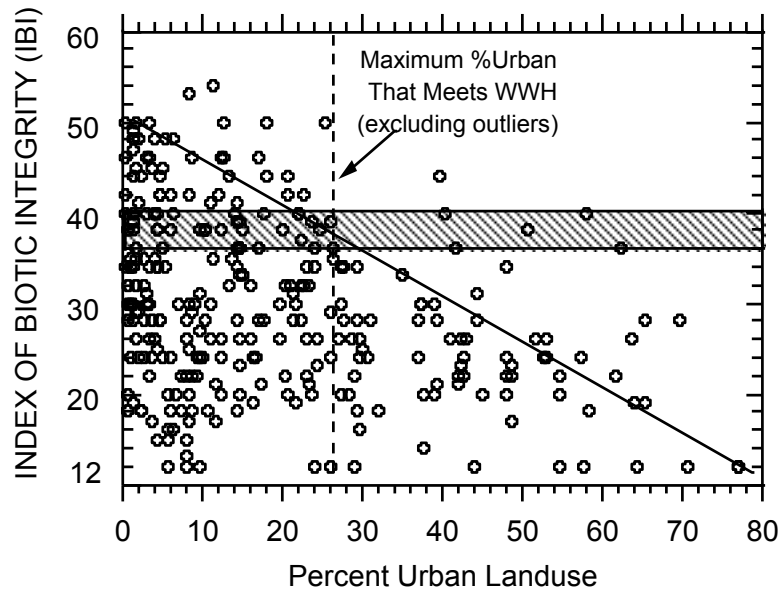


Inconsistent success of BMPs

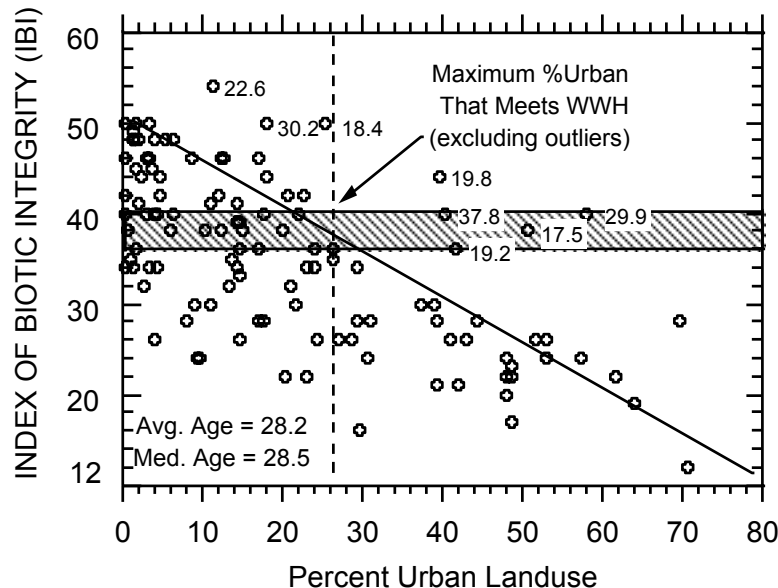
Aquatic Life Use Attainment Trend



ALL IMPACT TYPES



SELECTED IMPACT TYPES



IBI vs. % Urban Land Use

- Typical threshold for WWH attainment at 25-30% urban land use.
- No attainment at >60% urban land use.
- Attainment "outliers" occur at 40-60% urban land use.
- Characteristics common to outliers are good riparian, sustained flow, or <20 years of urban development.
- Removal of habitat, sewer overflow, and legacy impacts helped clarify IBI/urban land use relationship.

Strategic Support Provided Collectively by Rotating Basin Assessments

The ongoing accumulation of information across spatial and temporal scales

Policy Development

- TMDL Listing/De-listing
- Refined WQS Uses
- Antidegradation
- NPDES (WET, CSOs, Stormwater)
- 404/401 dredge & fill
- Stream Protection
- Nutrient management
- Overall program/policy effectiveness
- Environmental audits

Program Development

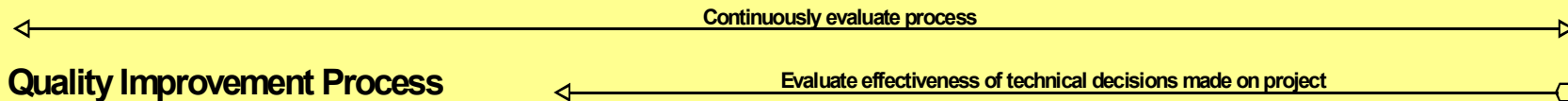
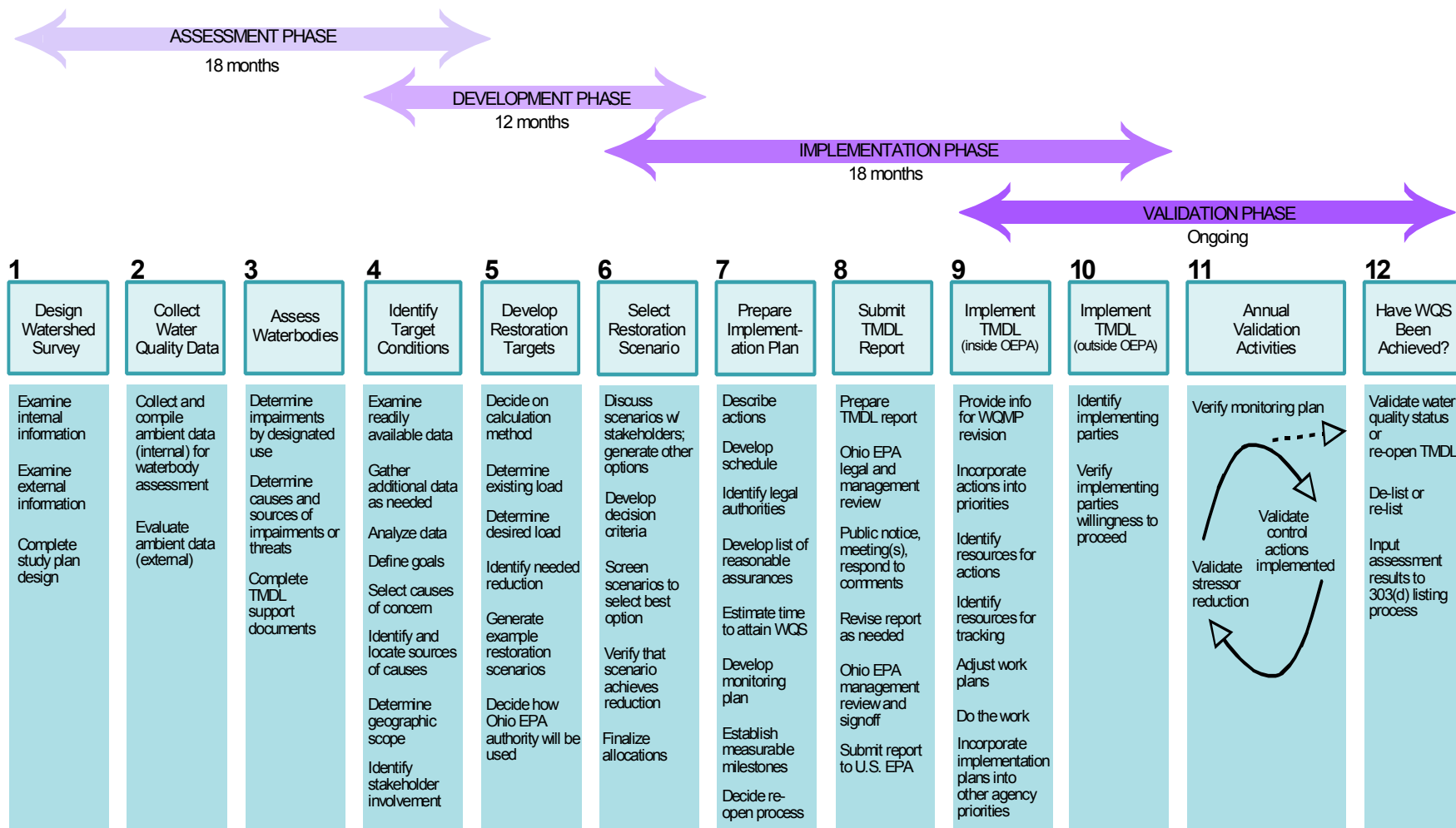
- Environmental Indicators
- Refined & Validated WQ Criteria
- Reference WQ & Sediment benchmarks
- Biological Criteria
- Biological Response Signatures
- Regional stratification (ecoregions, subreg.)

Statewide/Regional Applications

- TMDLs (303d)
- Status/Trends (305b)
- Local projects
- NPS/BMP effectiveness evaluations
- NAWQA/REMAP
- Watershed mgmt.
- SWAP
- UWA
- IWI "ground truthing"

Overview of the Ohio TMDL Project Process

Numbers on chart correspond to detailed task lists contained in Appendix B



IMPROVING THE TMDL PROCESS: PROGRESS TOWARDS A RESOURCE BASED APPROACH

Pollutant
Focused

TMDL = WLA + LA + MOS
(Lbs./day) (1 of Karr's Five Factors)

TMDL = f (WQ + Physical + Biota)
(Lbs./day) (3 of Karr's Five Factors)

**Use Attainment = f (WQ + Hydrological +
(Miles, Acres, Condition) Energy + Physical +
Biota)**
(5 of Karr's Five Factors)

Resource
Focused

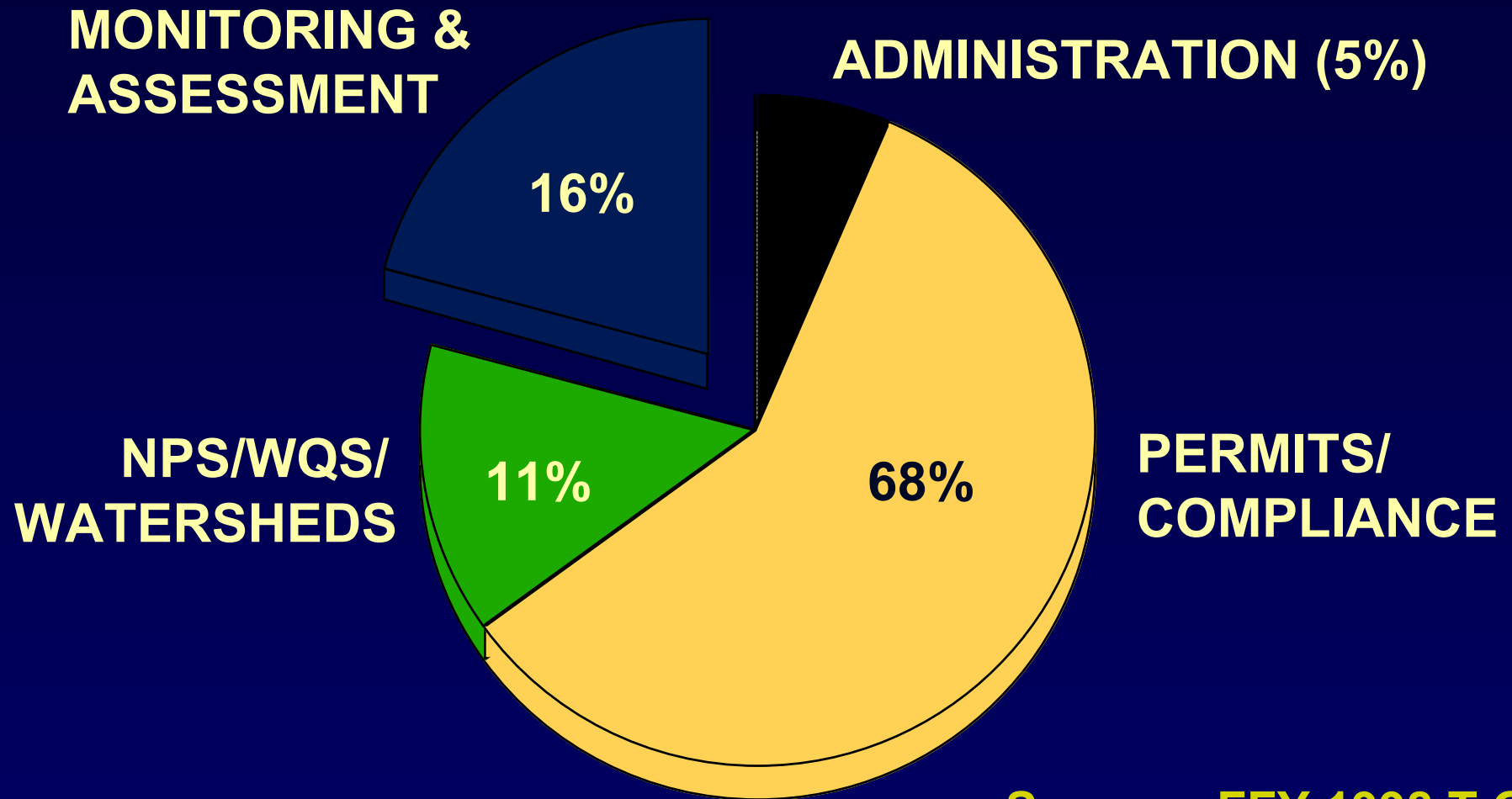
Essential Principles of Adequate Monitoring and Assessment Approaches

- **Data Quality Objectives:** need to produce data and information at a sufficient level of resolution so as to assure accuracy and precision.
- **Watershed Scale Assessment:** essential to encompass the full gradient of response and exposure to multiple stressors and influences.
- **Comprehensive Assessments:** integrated and careful analysis of multiple indicators adhering to a disciplined approach (Hierarchy of Indicators).
- **Learn by Doing:** gain new knowledge and insights by iterative assessment and observing responses to management actions (what works?).

Increasing the Capacity of State Monitoring and Assessment Programs is an Urgent National Priority

- Tiered uses and refined criteria, including numeric biological criteria
- Adequate M&A implemented by skilled and trained professionals, *consistent custody of assessment*
- Integrated assessment process at the same scale at which management is being applied

Ohio EPA Surface Water Program Resource Allocation by Functional Category



Source: FFY 1998 T.O.



The challenge for water quality management in the 21st century will be to incorporate the concepts of aquatic ecosystem functioning and health into water quality standards, monitoring and assessment, and regulation so as to stem the current declines in watershed health and the declining delivery of essential goods and services.